Central North Corridor Bus Service Study

Produced for the Massachusetts Bay Transportation Authority by the Central Transportation Planning Staff

Central North Corridor

Bus Service Study

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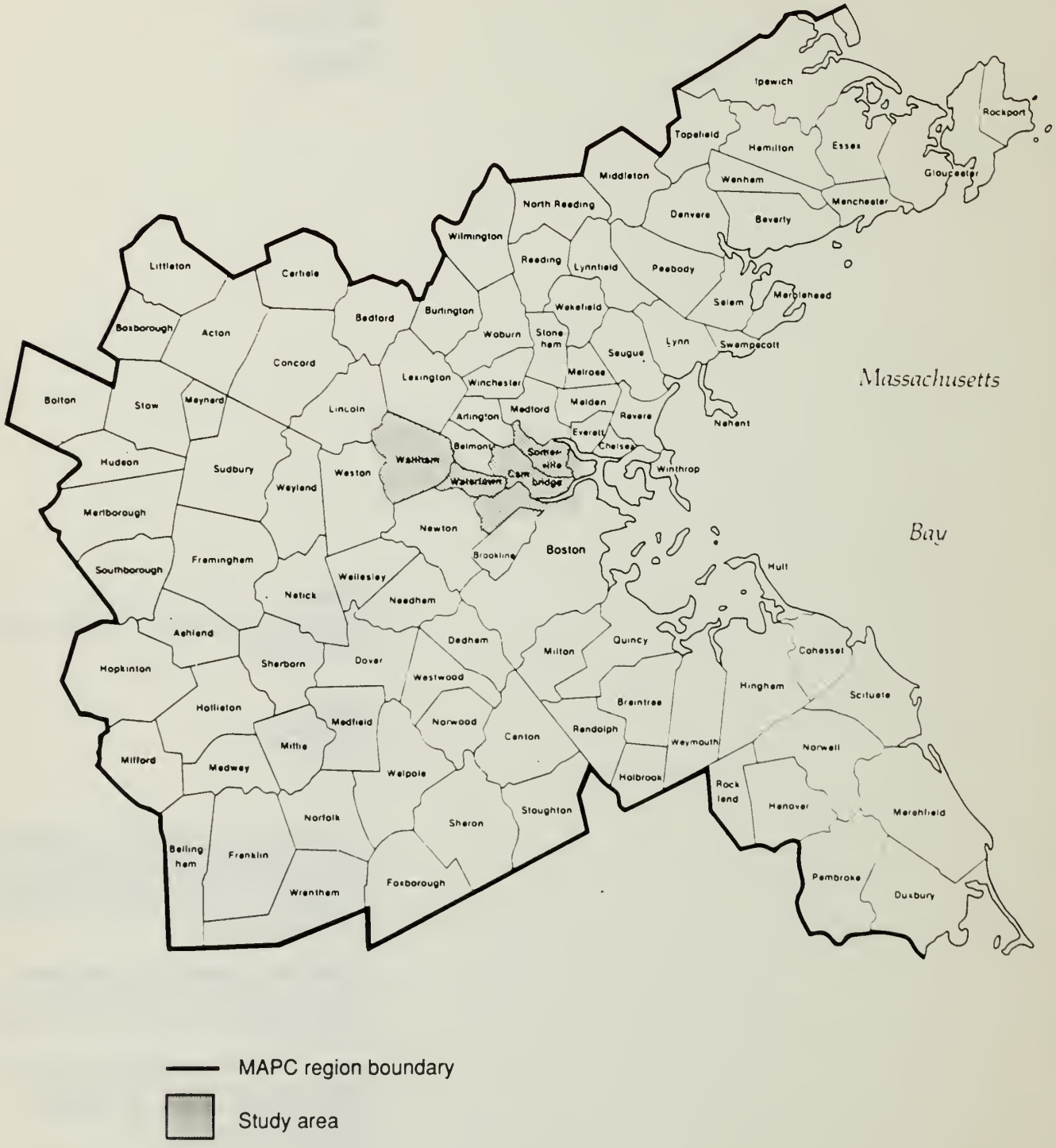

ABSTRACT

This report summarizes the results of a detailed study of fourteen MBTA local bus routes that operate primarily in Boston, Cambridge and Somerville. The study had two major objectives. The first was to develop recommended service improvements in response to several specific issues identified by the MBTA and community officials. The second objective was to document the ridership and performance characteristics of each of the routes, as part of the MBTA's ongoing bus corridor study process.

Included in the report are descriptions of data collection and analysis methods and a summary of findings and recommendations. Separately bound supplements contain technical memoranda and data produced during the course of the study.

TABLE OF CONTENTS

1 INTRODUCTION

The Central North Bus Study is one of several bus studies recently commissioned by the MBTA as part of its ongoing bus corridor planning process. This study consisted of collecting, organizing and analyzing a considerable amount of ridership data on fourteen bus routes, and of proposing ways to improve service.

The Central North Bus Study spanned a two-and-a-half year period and resulted in a large number of products. In all, ten technical memoranda and numerous computer reports, maps and other items were produced. The purpose of this final report is to summarize all aspects of the study, including data collection, analysis, findings and recommendations.

Chapter Two consists of a description of the study's background and the study area. Chapter Three is a description of the data collection and analysis methods employed in the study. The major portion of this report consists of Chapter Four, a summary of all findings and recommendations previously reported in the ten technical memoranda. A final chapter contains concluding remarks and a list of recommendations that were not implemented but that are still worth considering.

Two technical supplements accompany this report. The first contains the ten technical memoranda written over the course of the study and the second contains the most important of the computer printouts and miscellaneous documents produced.

2 BACKGROUND

2.1 PROJECT PURPOSE

The Central North Bus Study had two major goals. The first was to document the performance and ridership characteristics of selected bus routes at one point in time, as part of the MBTA's ongoing bus corridor study process. Much of the information collected was entered into the MBTA's Transit Information Manager System and is currently used by the Operations Directorate in various ways. CTPS also maintains the information in its databases and uses it when responding to MBTA requests for data or analysis.

The second goal of the study was to use the information collected to analyze various issues that the MBTA and community officials had identified. These issues ranged from analyzing ways of improving a particular route's reliability to analyzing the demand for more transit service in specific parts of the study area. There was no central unifying issue underlying this study, unlike, for example, the Northwest Corridor Study, in which the then-impending Red Line extension to Alewife compelled an examination of how to reorient bus routes.

2.2 PROJECT HISTORY AND CONTEXT

This is the third bus study done for the MBTA as part of its ongoing bus corridor planning process. The first, the Northwest Corridor Bus Study, was done by Cambridge Systematics Incorporated, and the second, the South Shore Corridor Bus Study, was done by CTPS.

This study was begun in the fall of 1984. Ridecheck data were collected then and survey data were collected in the winter of 1984/85. After the data were collected, organized and submitted to the MBTA in fulfillment of the first study goal, the CTPS study team was asked by the MBTA to work on a more pressing issue, and, in consequence, the analysis phase did not commence in full until later in 1985. Analysis was subsequently interrupted several more times by more pressing projects and was not substantially completed until 1987. The ten technical memoranda, noted previously, were produced at different times over this several-month period.

An analysis of whether to restore trolley service on the A-line branch of the Green Line was originally part of this study, but it was later separated.[1]

2.3 STUDY ROUTES/STUDY AREA DESCRIPTION

2.3.1 Bus Routes

There are fourteen bus routes in the Central North Corridor (see Figure 2-1). All are well established local routes and all connect to the MBTA rapid transit system. The routes do not form a clear geographic corridor in the usual sense. Instead, they consist of those in Cambridge and Somerville not studied as part the Northwest Corridor Study, and those that serve Allston/Brighton and Fenway/Parker Hill. Some of them extend into other communities. Major focal points are Central and Harvard squares in Cambridge, Kenmore Square, and Union Square in Allston. The following are the fourteen study area routes:

1 Harvard Square to Dudley Station
47 Central Square to Boston City Hospital[2]
57 Watertown Square to Kenmore Station
60 Chestnut Hill to Kenmore Station
63 Cleveland Circle to Central Square
64 Oak Square to Central Square
65 Brighton Center to Kenmore Station
66 Union Square Allston to Dudley Station
69 Harvard Square to Lechmere Station
70 Cedarwood, Waltham, to Central Square
83 Rindge Ave., Cambridge, to Central Square
85 Spring Hill, Somerville, to Kendall Square
86 Union Square, Allston, to Sullivan Station
90 Central Square to Sullivan Station

Most of the routes connect to other study area routes. Many connect to routes outside of the study area. Two such routes--1 and 47--were also included in another corridor study which had as its focus the then-impending Orange Line relocation.[3]

2.3.2 Study Area

The study area consists mainly of Cambridge, Somerville, Allston/Brighton and Fenway/Parker Hill. However, as mentioned, various routes also extend to other communities and neighborhoods. These include Waltham, Watertown, Newton, Brookline, Back Bay, Roxbury and the South End.

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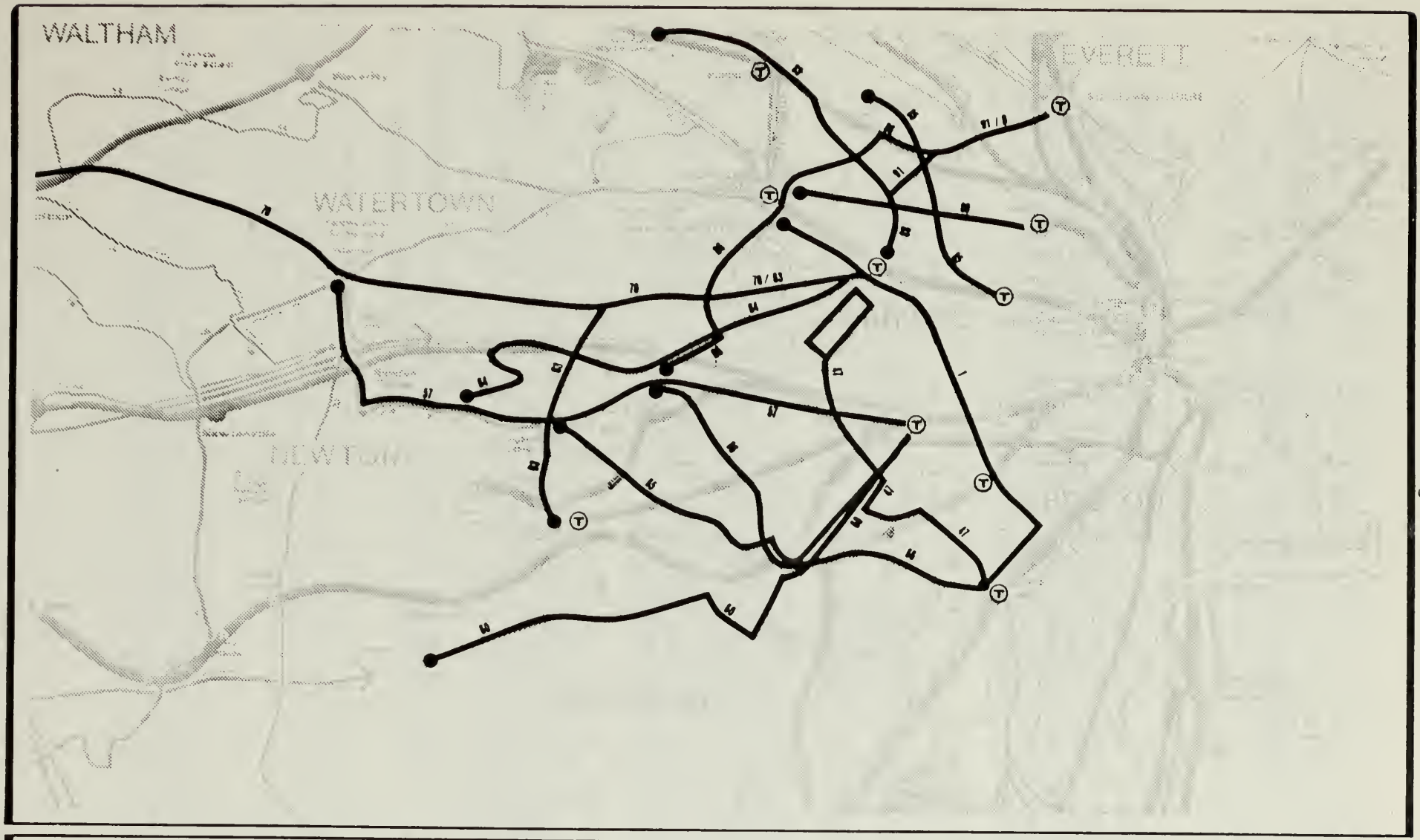
[1] Watertown Trolley Analysis, CTPS draft report, April 1988.
[2] As of the Orange Line relocation in the late spring of 1987, this route terminates at Andrew Station instead of Dudley Station.
[3] Southwest Corridor Bus Operations Study, done by Tippets-Abbett-McCarthy-Stratton (TAMS) for the MBTA, July 1986.



Central North Corridor Bus Service Study	CENTRAL NORTH BUS ROUTES	CTPS
Technical Report 62 July 1988		FIGURE 2-1

Except for its western fringes, the study area is densely populated (12,000 per square mile throughout most of the area) and well established. Population declined by 11 percent between 1970 and 1980, but has begun to stabilize since then. Only modest population declines are projected through 1990. Employment increased by 16,200 between 1980 and 1985 and is projected to increase by 10,000 between 1985 and 1990.

In most areas, transit dependency due to a lack of an automobile is significant. Overall, roughly one-third of the study area's households lack an automobile, but the figure exceeds 50 percent in the Fenway, Roxbury and the South End. Other indicators, such as household income and age, also imply a study area population that is quite transit-dependent. (See "Central North Bus Market Analysis" in Supplement 1 for a detailed description of study area characteristics.)

In addition to local buses, the study area is served by the Red, Orange and Green rapid transit lines, and by commuter rail at Porter Square, Cambridge. At Newton Corner, Watertown Square and Brighton Center, MBTA express bus service is provided also.

2.3.3 Study Area Changes Since 1984/85

After most of the data had been collected and some recommendations had been set forth in technical memoranda, two major changes occurred in the study area transit network. First, the Red Line extension to Alewife was opened in late 1984. The extension has reduced ridership on Route 83, Rindge Avenue to Central Square. In consequence, the route's headways were lengthened, but the routing was not changed.

Second, in the spring of 1987, the relocated Orange Line was opened. As part of reorienting bus service in Roxbury and Dorchester, Route 47 was extended from Boston City Hospital to Andrew Station. (Routes 1 and 66 were left to terminate at Dudley Square, but the former was rerouted back over the Massachusetts Avenue bridge.)

These changes rendered some of the data and recommendations obsolete. Such instances are noted in due course.

3 DATA COLLECTION/ANALYSIS METHODS

3.1 DATA COLLECTION AND ORGANIZATION

Before data collection commenced, each route was field-checked in order to ascertain the locations of bus stops and the distances between stops. See "Data Collection" in Supplement 1 for detailed information about the data collection phase of the project.

3.1.1 Ridecheck Data

Most information used in the Central North Bus Study analysis was obtained in ridechecks conducted in the fall of 1984. Each bus trip was ridechecked at least once. Boardings, alightings and elapsed time between time points were recorded.

The data were organized into various reports for use in analysis. Chief among these reports were so-called "bus trip summaries" which list, among other things, boardings, alightings and maximum loads per one-way bus trip. "Load profiles," showing the number of passengers on board buses at each stop, were also produced. Bus running times by route segment, direction and time period were summarized in separate reports. All of these reports are contained in Supplement 2.

Apart from calculating ridership on each route, the ridecheck data were used mainly to compare bus loadings with bus capacity and actual running times with scheduled running times. These comparisons yielded information about where service might be changed. The data were also used to expand the on-board survey information discussed below.

3.1.2 On-Board Survey Data

On-board surveys, conducted in the winter of 1985, provided the second major source of data for the study. The questionnaire form elicited information about trip characteristics, such as origin and destination, user characteristics, such as income, and user attitudes about the bus service.

Survey data were organized into frequency distribution reports (contained in Supplement 2). These reports provide an overview of the ridership characteristics on each route by presenting the distribution of riders across each characteristic.

In addition to providing route overviews, the survey data were used to calculate passenger revenue, transfer rates between bus routes and various other items.

3.2 ANALYSIS METHODS

Analyses undertaken throughout this study fall into three general categories: route level, system level, and latent demand. In the first, a particular route was examined in detail to see whether and how its productivity or reliability could be improved. A combination of ridecheck data, field checks and judgment was employed in this type of analysis. Performance measures were constructed from the raw data. Passenger loads and running times were examined and compared to standards and to other routes. Specific bus trips, route segments, and even particular bus stops were often the focus of the analysis. Examples of this are the Route 47 and Route 66 analyses.

The second general type of analysis involved looking at a group of routes to see how they interact and how they serve identified travel needs in an area. At this level, such things as how schedules coordinate and the number of riders transferring between two given routes were examined. Survey data were relied upon rather heavily in these instances. Examples of these analyses are the Market Analysis and the Schedule Coordination Analysis.

Finally, some issues called for an analysis of latent demand for new or reoriented bus service. In these cases, judgmental demand-estimation techniques, relying heavily on U.S. Census journey-to-work data, were developed. An example of this type of analysis is the Somerville/Cambridge crosstown analysis.

3.3 STUDY PRODUCTS

Below are lists of all of the items produced over the course of this study and their dates of delivery to the MBTA. Most of them have been compiled in the two separately bound supplements to this report. Supplement 1 comprises all of the memoranda; Supplement 2, the data reports and most of the miscellaneous items.

3.3.1 Memoranda

Data Collection	5/08/85
Route 70 Analysis	7/11/85
Bunching of Buses on Brookline Ave.	9/19/86
Route 47 Unreliability	9/19/86
Schedule Coordination of Central North Routes	12/19/86
Route 66 Unreliability	1/12/87

Bus Route Productivity, Efficiency and Reliability	1/28/87
Central North Bus Market Analysis	4/07/87
Kendall Square/Central Square Bus Service	6/22/87
Somerville/Cambridge Cross-town Routes	10/30/87

3.3.2 Data Reports

Trip Summaries (ons, offs & max loads)	5/30/85
Locations of Passenger Home Trip-ends	6/12/85
Bus Running Time Graphs	6/12/85
Bus Running Time Summary Statistics by Period	7/23/85
On-board Survey Responses (Frequency Dists.)	7/24/85
Load Profiles and On/Off Tables - All day	7/31/85

3.3.3 Miscellaneous

Bus Stop Lists	5/23/85
Ridecheck Data on Floppy Diskettes	5/23/85
Bus Route Time Point Locations	7/23/85
Bus Route Peak Load Locations by Period	8/07/85
Wall Map of Corridor Bus Routes	May '85
Wall Map Overlays (Pop. Densities, etc.)	July '85

4 SUMMARY OF FINDINGS AND RECOMMENDATIONS

This chapter is a summary of the findings and recommendations made over the course of the study. First, a general assessment of service is provided. The specific findings and recommendations summarized afterwards are all taken from the technical memoranda. Some of these (as will be noted in each case) are based on service that has since been changed and they therefore do not reflect present conditions. All, however, are reported here in the interest of having one central record of the results of what amounted to a very large body of analysis.

4.1 OVERALL ASSESSMENT OF SERVICE

Based on the analysis done, it was found that nearly all existing bus service is routed as it should be. This might be expected given that the study area routes are well established and that few alternative routings are available anyway. In addition, with the exception of the Kendall Square area, no significant land use changes that would dictate routing changes have occurred recently.

Viewed as a system, the routes provide excellent coverage. With few exceptions, bus or rail service is provided within one quarter mile of all residents, and all major travel generators are served.

For the most part, the level of service on the routes is in line with observed demand. This is shown by route statistics that indicate the routes are productive but not overcrowded. Places where level-of-service changes are warranted are noted in Section 4.2.

Service is generally reliable based on most available measures. Serious reliability problems were found to have workable schedule-based solutions (Routes 47 and 66). Less serious problems were also found to have such solutions. These problems were often a result of running times' being different from those assumed in scheduling. The provision of new running times from this study should, therefore, help in updating outmoded book times as new schedules are constructed.

These new times should also help in "tightening up" schedules that appear to have too much slack. In many of these cases, though, such tightening up is not sensible. If service is well

balanced with demand and/or operating on clock-face headways, it should not be tampered with on a piece-meal basis in order to achieve small efficiency gains.[4] In the future, computerized, global scheduling will make such efficiencies possible. It should also make greater schedule coordination possible.

One of the largest problems facing bus service provision in the study area is one the operator has no control over: traffic congestion. It is a major contributor to buses' running off-schedule. Using the best available running time information in scheduling, and informing passengers of this information (via accurate running times on schedule cards, for instance) are the best low-cost means of dealing with the effects of congestion-caused delays.

4.2 SPECIFIC FINDINGS AND RECOMMENDATIONS

In this section, each issue examined over the course of the study is paired with the findings and recommendations made at the time. As noted earlier, some service has changed--as a result of the study findings or for other reasons; these changes are noted.

ROUTE 70, CEDARWOOD - CENTRAL SQUARE

Issue: Route 70 was, for quite some time, criticized by patrons and some public officials for being overcrowded and unreliable. Peak-period service had been supplemented by short-turns between Watertown Square and Central Square due to previous complaints of overcrowding.

Analysis: CTPS analyzed the effects on peak loads and passenger waiting times of three different operating strategies: (a) current service, (b) extending short-turns to Waltham Center and decreasing the number of short-turns and regular trips, (c) eliminating all short-turns and operating the route as it had been in the past.

Findings: Both alternative b and alternative c would relieve overcrowding and improve reliability. Alternative b would inconvenience more individuals than it would benefit, but it would reduce the worst crowding to within standards and result in even trunk headways, while having the added benefit of saving a vehicle in each peak. Alternative c would decrease crowding more, and would decrease overall passenger wait time.

Recommendation: No single recommendation was made, but either b or c was preferred to the do-nothing alternative.

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[4] Small gains are defined as those that do not involve the saving of a bus.

Action: Option c was selected. The short-turn was eliminated and peak-period headways were reduced from 20 to 15 minutes. (The short-turn was later revived on Saturdays only.)

See "Route 70 Analysis" in Supplement 1 for more information.

ROUTES 60 AND 65

Issue: These two routes, the first operating between Chestnut Hill and Kenmore Station and the second between Brighton Center and Kenmore, converge on Brookline Avenue in the Longwood medical area. Officials and riders had expressed concern that the buses on these routes often bunch up along Brookline Avenue, creating reliability and traffic problems.

Analysis: Using ridecheck data, actual running times and headways for a "composite day" were established and the interaction of the two routes on their common segment was examined. Actual average headways and their standard deviation, and actual versus scheduled arrival times at time points were used to measure platooning.

Findings: Platooning did, in fact, occur on Brookline Avenue in peak periods. At the time of analysis, two variations were operated on Route 60 in the peaks, so three route variations in total (60.0, 60.1 and 65.0) converged on Brookline Avenue. Three factors were found to contribute to the platooning problem:

a) Inbound buses were scheduled so as to mesh on the trunk at irregular intervals.
b) Outbound buses, although scheduled out of Kenmore on fairly even trunk headways, could platoon towards the end of the trunk, due to uneven demand between the two routes.
c) Actual running times often exceeded scheduled running times, which led to recovery time often being insufficient. While not necessarily a direct cause of platooning, this contributed to buses' remaining off schedule once they became so.

It was also found, incidentally, that short-turn variation 60.1, Cypress and High streets to Kenmore, was among the least productive variations in the study area.

Recommendation: Based on the last finding, it was recommended that variation 60.1 be eliminated in order to serve the dual objective of lessening platooning and freeing up unproductive bus capacity for use elsewhere. In addition, it was recommended that the Cypress and High street neighborhood be served by deviating the remaining Chestnut Hill-to-Kenmore variation during peak periods.

Action: The recommended changes were incorporated in the Winter 1986 timetable.

See "Bunching of Buses on Brookline Avenue" in Supplement 1 for more information.

ROUTE 47, CENTRAL SQUARE - BOSTON CITY HOSPITAL

Issue: This route had, for a long time, been considered by riders and the operator to be among the least reliable in the system. The major variation is supplemented by a short-turn variation during peak periods which operates between Brookline Avenue and Boston City Hospital.

Analysis: A variety of information sources were analyzed to gauge the extent of the problem. From ridecheck data, actual terminal departure times and running time variability were examined. Scheduled trunk headways (47.0 and 47.4) were tracked to see how the two variations were intended to interact. On-board survey data yielded passenger perceptions of the route and field observations yielded additional information.

Findings: The route indeed had a measurable reliability problem--the worst of any route in the study area. A combination of factors was found to contribute to the problem:

a) An operating environment consisting of a long route operating over extremely congested streets.
b) Very heavy patronage, contributing to buses' becoming increasingly off-schedule once they fell behind.
c) A schedule with insufficient peak-period recovery time and irregular trunk headways.
d) Dispatching practices which sometimes heightened impressions of unreliability. This was found to be a minor consideration.

Recommendations: Improving dispatching, signing and public information was recommended as an adjunct to the more important objective of giving buses a greater chance of maintaining schedule. Specifically, the following was suggested as a way of meeting this objective:

a) In the AM peak period, add one vehicle to each variation. This would allow an attendant reduction of headways by one minute.
b) In the PM peak period, even trunk headways and add one vehicle to the short-turn 47.4 variation.

Actions: In response to the larger issue of how to reorient bus service to the relocated Orange Line (an issue analyzed by the MBTA concurrent with the CTPS analysis), the major variation, 47.0, was extended to Andrew Station on the Red Line, with a

consequent addition of one vehicle per peak. In addition, two vehicles were added to the AM peak schedule of 47.4 and one was added in the PM peak, with consequent slight headway reductions in both cases.

See "Route 47 Unreliability" in Supplement 1 for more information.

ROUTE 66, UNION SQUARE - DUDLEY SQUARE

Issue: This route, like Route 47, was deemed to have a serious reliability problem.

Analysis: As with Route 47, the schedule and running time characteristics of the route were examined in detail.

Findings: Measurable reliability problems were found to exist and were a function of:

a) High running time variability along the route, caused mainly by an operating environment characterized by very heavy traffic on narrow streets.
b) Insufficient recovery time at the Dudley Square end of the route.

Recommendations: Strategies for increasing recovery time were recommended as follows:

a) In the AM peak period, add one bus and reduce headways from 7.5 to 7.0 minutes (this would relieve crowding also).
b) In the midday, shift four minutes of recovery time from Union Square to Dudley Square.
c) In the school peak, add one bus.
d) In the PM peak, lengthen headways from 8.5 to 10.0 minutes. Load standards would not be violated.

Actions: None of the recommended changes have been implemented as yet.

See "Route 66 Unreliability" in Supplement 1 for more information.

KENDALL AND CENTRAL SQUARES, CAMBRIDGE

Issues: Two interrelated issues had been in the minds of Cambridge officials for some time. The first was that significant development in Kendall Square implied a probable need for increased bus service there and the second was that too many buses were laying over in Central Square.

Analysis: The two issues were analyzed jointly. Ridecheck and schedule data were used to judge whether and how bus layovers could be gotten out of Central Square. Options considered were route extensions to Kendall, schedule adjustments and route combinations.

U.S. Census journey-to-work data and on-board survey data were used to estimate the demand for increased bus service to Kendall Square. Options considered were route extensions from Central Square and new service along four different alignments from Sullivan, Wellington and Medford squares.

Findings:

a) Extending routes from Central would be a reasonable, cost-effective way of both reducing bus presence there and increasing service to Kendall.
b) Demand for more transit service from Somerville and Medford to the Kendall area exists.
c) Other than extending routes to Kendall, little else can be done to reduce bus presence in Central. Schedules had already been altered to minimize layover time, and route combinations, given the existing running time variability of candidate routes, would create unreliable, long routes.

Recommendations:

a) If any routes are extended, the following should be, based on market and operating considerations:

   - Route 64, Oak Square to Central Square
   - Route 70, Cedarwood to Central Square (extend in peak periods only)
   - Route 91, Sullivan Square to Central Square

b) If completely new service to Kendall is instituted, the following routes should be considered, based on performance and the objective of serving identified markets not currently well connected by transit:

   - Wellington to Kendall via Ten Hills, City Hall, Union Square and Inman Square
   - Medford Square to Kendall via Main, Lowell and Summer streets, Union Square and Inman Square

Actions: None of the recommended changes has been implemented as yet.

See "Kendall Square/Central Square Bus Service" in Supplement 1 for more information.

SOMERVILLE-TO-CAMBRIDGE CROSSTOWN SERVICE

Issue: Somerville officials had, for some time, been interested in having a bus connection between the center of the city and a major Cambridge activity center such as Harvard Square.

Analysis: U.S. Census journey-to-work data were used to estimate patronage on four alternative alignments connecting Wellington Station with either Porter or Harvard Square and operating through the center of Somerville. In addition, all alignments were field-checked for logistical problems, which were thought by the operator to be considerable.

Findings:

a) Logistical problems, in the form of steep grades, narrow streets and tight turns, would indeed be significant, but quite possibly surmountable. Qualified MBTA personnel would have to evaluate.
b) All alternatives would be among the lowest performing, lowest patronized routes in the Cambridge/Somerville area.
c) Harvard Square would be better than Porter Square as a route terminus.

Recommendations: Drop this type of route from consideration, for now. Given its relatively low performance, it would be difficult to justify. It might do better in the future, given current trends in employment, congestion and parking costs. Moreover, the route's objectives might be served in the context of a more ambitious crosstown transit service, currently being analyzed by the MBTA in the "Circumferential Transit Feasibility Study."

Action: No new crosstown service has been implemented.

See "Somerville/Cambridge Crosstown Routes" in Supplement 1 for more information.

SCHEDULE COORDINATION AMONG ROUTES

Issue: In the study area, over half of the bus passenger-trips require a bus or rail transfer; over one-quarter require a bus transfer. Coordination of bus schedules could potentially reduce transfer time for existing passengers and generate additional riders.

Analysis: Minor schedule changes--those that could be made easily and would not lead to other problems away from the point of coordination--were examined. Passenger flows from route to route were determined from on-board survey data.

Findings: Among the fifteen pairs of study area routes with the highest daily transfers, five were found to be subject to coordination through minor adjustments, with no need for additional resources and no violation of load standards.

Recommendations: The following five route pairs were suggested for coordination:

a) Routes 57 and 60 at Kenmore Square
b) Routes 57 and 65 at Kenmore Square
c) Routes 47 and 91 at Central Square
d) Routes 70 and 83 at Central Square
e) Routes 66 and 86 at Union Square, Allston

Actions: No changes have been made.

See "Schedule Coordination of Central North Routes" in Supplement 1 for more information.

MARKET ANALYSIS

Issue: Most of the analysis done for the Central North Bus Study was of specific issues associated with specific routes. It was also deemed necessary to examine all fourteen study area routes together to see how they, as a system, met study area demand for transit services and to see how the system might be improved. Such a global analysis was one of the first products of the study, and some of the recommendations that resulted were addressed in subsequent analyses.

Analysis: The transit supply, in the form of the fourteen study area routes, was compared to MBTA service standards and demand-side information. U.S. Census socioeconomic information was used to describe the makeup of the area and to gauge the current and anticipated level of transit dependency in the area. U.S. Census journey-to-work data were used to map general auto and transit travel patterns, and on-board survey data were used to track transit passenger-trips through the system.

Findings: Several general findings were reported. Those with implications for service improvement are as follows:

a) The study area is generally well served by transit. With few exceptions, bus or rail transit is available within one-quarter mile of all residents. Major travel generators are well served and transit services generally have high levels of service. At least a basic level of transit service is clearly being provided.

b) Most zone-to-zone interchanges have direct transit service and have an expected level of transit usage; the most significant exceptions are:

- From the central part of Allston/Brighton to the CBD, Back Bay and Fenway/Parker Hill

- From the northern part of Allston/Brighton to the southern part

- From central Somerville to Harvard Square and East Cambridge

c) Transit ridership in the corridor is high and the patrons are largely transit dependent (88 percent of the bus riders do not own a car). In order to gain more "discretionary" ridership, transit travel times would have to be made more competitive with auto travel times.

d) Twenty-nine percent of corridor bus riders transfer between at least two bus routes. This exceeds the MBTA standard of 25 percent. However, since transfers are spread over 56 different routes, no single route pair or set of pairs can be modified to significantly lower the percentage. No single route pair meets the guidelines for through-routing (transferees must equal at least 20 percent of one route's ridership), nor would any route extension eliminate an appreciable number of transfers.

Recommendations: The market analysis served to identify issues examined in other, later analyses. As such, products were in the form of suggestions for further analysis rather than specific service changes. For example, Somerville crosstown service and increased service to East Cambridge were issues mentioned as definitely needing more analysis.

See "Central North Bus Market Analysis" in Supplement 1 for more information.

PRODUCTIVITY AND RELIABILITY

Issue: Most of the issues addressed in the Central North Bus Study pertained to specific concerns about specific routes. The issue of reliability was touched on in only a couple of these instances (see the Route 47 and Route 66 analyses, above) and productivity not at all. However, an analysis was done in which the performance of all fourteen study area routes was surveyed with the single objective of developing recommendations for schedule-based changes to enhance productivity and reliability, where appropriate. This analysis was not intended to look at all aspects of routes (design, for example) or to come up with a service plan for the corridor.

Analysis: Boardings and running time data from ridechecks were summarized and compared with MBTA service standards and schedule statistics. The three major areas of concern were low boardings productivity, crowding and on-time performance. Deviations from standards or corridor averages were flagged and examined for possible causes and corrections.

Findings:

a) Generally, Central North routes were found to be productive: patronage was quite good compared to the levels of service. This led to farebox recovery on all routes being above standard.

b) Serious crowding was found to be infrequent, concentrated on a few routes and of short duration.

c) On-time performance, while a serious concern on a few routes, was also generally within MBTA standards. Problems, where they occurred, were largely due to insufficient cycle times which were, in turn, due to outdated scheduled (book) times.

d) In several instances, the opposite was found to exist: cycle-to-running time ratios exceeded the 1.30 standard. In many of these instances, though, making schedule adjustments would not be sensible: clock-face headways would be destroyed or loads increased in order to achieve marginal schedule efficiencies.

Recommendations: Adjustments to the number of vehicles and/or to headways were found to be appropriate means for remedying the few serious problems uncovered and for "tightening up" service even where no serious problems were found. A brief summary of selected recommendations follows. See "Bus Route Productivity, Efficiency and Reliability" in Supplement 1 for more information, including some non-schedule-based recommendations.

a) Route 1, Harvard Square - Dudley

- Improve PM peak on-time performance by increasing the cycle time through the addition of one vehicle.

  (This was subsequently done.)

- Obtain the extra vehicle by deleting one from the evening period. The consequent 77-minute cycle time will be sufficient to ensure on-time evening departures.

b) Route 47, Central Square - Boston City Hospital

This route was examined in great detail in a separate analysis. Refer to the previous section of this chapter for information.

c) Route 57, Watertown Square - Kenmore Square

- Improve AM peak on-time performance by adding one vehicle or lengthening headways by one minute. Alternatively, to bring loads within standard, add three vehicles and shorten headways by one minute.

- Tighten up school and evening schedules by dropping a vehicle from each. The consequent cycle-to-running time ratios of 1.23 and 1.25 would be sufficient.

d) Route 65, Brighton Center - Kenmore Square

- In the AM peak, shift recovery time to the Kenmore end, to reduce late outbound departures.

- Shift eight minutes of cycle time from Route 60.0 to 65 in the latter part of the midday period, when they are interlined. The former does not need that time, and the latter has late departures then.

e) Route 69, Harvard Square - Lechmere Station

- Provide one additional trip in the AM peak half-hour (7:40 to 8:10 AM), to relieve overcrowding.

  (This crowding was subsequently addressed by changing from 2 x 20 to 7 x 7 in the peak half-hour.)

- Eliminate one of the four vehicles in the school period, in order to tighten up the schedule. The consequent 38-minute cycle time will ensure 90 percent on-time performance.

f) Route 86, Union Square, Allston - Sullivan Square

- Enough slack exists in the midday, school and night schedules that service could be extended to Brighton Center, providing direct Harvard Square-to-Brighton service for part of the day. Alternatively, go from 4 x 20 to 3 x 22 in the school period. Non-clock-face headways would result, but a vehicle would be saved for use elsewhere.

g) Route 91, Central Square - Sullivan Square

- Drop a vehicle and lengthen headways by five minutes in the AM, midday, school and PM peak periods, in order to free up capacity for use elsewhere. The current cycle-to-running time ratios all exceed 1.30.

  (The vehicles were subsequently dropped, but headways were lengthened by 10 minutes.)

5 CONCLUSIONS

The Central North Bus Study accomplished four things. It provided a large body of ridership data for use in assessing service now and in the future. It generated several specific recommendations for dealing with problems that had been identified beforehand by the operator. It also led to some proposals for improving service in problem areas that became apparent only after data were collected and analyzed. Lastly, it pointed to issues that should be investigated further as time and resources permit.

The study also did not accomplish some things. It did not lead to a comprehensive service plan for the corridor. The study was not structured in such a way or done in a sufficiently compact period of time that such a purpose could be served. The analysis done was very issue-specific (specific to several issues rather than one unifying issue) and, even though some system-level analysis was done, the study had not examined all service aspects of all routes by the time the analysis was complete. In consequence, the study's products cannot be said to form a comprehensive service plan for the Central North Corridor. (The routes do not even form a corridor in the normal sense: four different bus garages are involved, for example.)

The bus routes in the study area were generally found to be routed as they should be, to be provided with a level of service in line with observed demand and to operate within MBTA standards for reliability. Exceptions to these findings were identified and, in most instances, workable solutions were found.

In some cases, to solve a problem is not wholly within the power of the operator. A major and obvious impediment to providing on-time bus service in the study area is traffic congestion. The operator cannot control traffic congestion, but if up-to-date running time information is used in scheduling, and if this information is also provided to riders (on schedule cards), then real and perceived reliability will be enhanced.

As is apparent in Chapter 4, most recommendations presented in the ten technical memoranda involved relatively modest schedule changes, even in cases where an identified problem was particularly significant. The proposals for providing new service to Kendall Square were, of course, larger in scope. Unfortunately, because the study spanned many months, it is difficult to summarize, in current terms, the total effects of the recommendations on variable costs and vehicle requirements.

Several of the recommendations made throughout this study have been implemented. Among those that have not been are those that were superseded by other service changes made to satisfy other objectives. Other recommendations not implemented were longer-term in nature and would not have been implemented immediately. Still others may have been considered and shelved for various reasons.

The recommendations that are still worth considering are summarized below. In some cases, in order to ensure that a recommendation made some time ago is still valid, spot-checks to obtain current data on a route's operation would be necessary.

Route 66: All schedule changes recommended for improving reliability are probably still valid. The route was having significant reliability problems when it was analyzed, but the recommendations should be checked for validity under current operating conditions.

Kendall/Central Squares: If other means for increasing transit service to Kendall Square (e.g., through a circumferential fixed-guideway routing) are not implemented, then all route extensions and new routes recommended remain valid ways of achieving this objective. The recommended route extensions also represent a viable way to reduce bus presence in Central Square.

Schedule Coordination: The recommendation that five route pairs be coordinated is probably still valid, if other scheduling constraints allow.

Route 57: Unless reliability and crowding have been improved by other means, or other relevant conditions have changed, adding three vehicles and shortening headways by one minute in the AM peak should still be appropriate. Given the controversy over whether to replace this route with trolley service, special attention to the route's identified problems is highly appropriate.

Route 65: Both recommendations for improving on-time performance are probably still valid, but they should be checked for validity under current conditions.

Route 86: If the schedule slack identified previously still exists, operating off-peak service to Brighton Center would still represent a low-cost service improvement--for part of the day, at least. One possible drawback to this is that patrons, once introduced to off-peak service to Brighton Center, would press for a peak-period extension, which would require additional resources.